

How to Build LAS Datasets and Render in 3D Using ArcGIS for Desktop

This tutorial will show you how to build an LAS Dataset and view 3-dimensional rendering of LiDAR data in ArcGIS for Desktop. This tutorial requires Spatial Analyst and 3D Analyst extensions.



What is LAS?

LAS is the industry-standard file format for storing airborne LiDAR data.

What is an LAS Dataset?

LAS datasets store reference to one or many LAS files on disk. LAS datasets can also store additional surface features such as breaklines, area boundaries and other polygon constraints. With an LAS dataset, you can generate statistics on the native LAS file and quickly and easily view, manage and edit large areas of LiDAR data.

When is an LAS Dataset appropriate?

LAS datasets are appropriate for organizing large collections of LAS files. You can edit point classifications of the LAS points, conduct quick statistical analyses, examine the LAS points as a mosaic and view in 3D, and create additional surfaces such as DEMs, DSMs and TINs.

In this tutorial we will build an LAS dataset and explore the point cloud in ArcGIS for Desktop. We will examine the statistics and view LAS in 3D as well as generate digital surface and elevation models from the LAS dataset.

[Create LAS Dataset](#)

[Examine Statistics](#)

[3D Point Cloud](#)

[Create Surface Models from LAS](#)



Create LAS Dataset

Similar to a mosaic dataset, the LAS dataset simply references files on disk. This allows for minimizing required storage space as well as limiting redundancies in your data.

However, it is always recommended to keep an archive of your LAS files. Any changes to point classifications made in the LAS dataset will apply to the native LAS file as well. These changes are irreversible; therefore maintaining a collection of backup LAS files is prudent.

1. Open ArcMap
2. Search for tool “Create LAS Dataset” (Data Management).

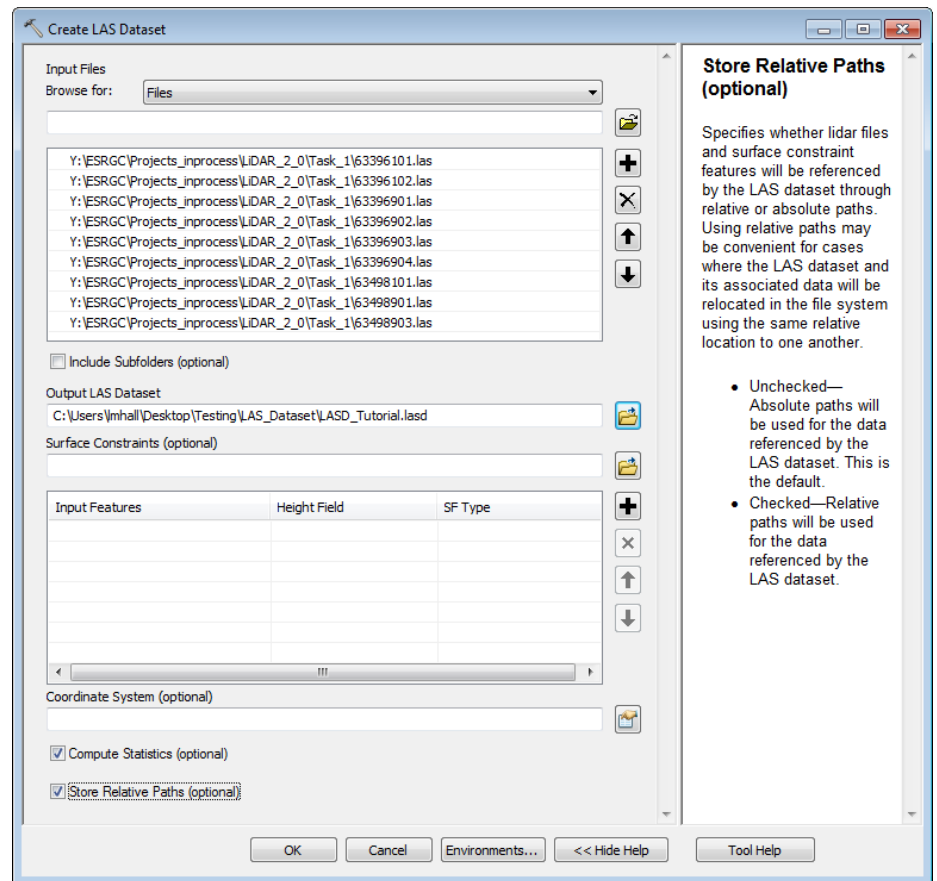
Browse for input LAS files

Set output LAS dataset location and name.

Add optional surface constraints (omitted for this tutorial).

Set optional coordinate system (omitted for this tutorial as the default will pull from the LAS file).

Check the boxes for “Compute Statistics” and “Store Relative Paths”.



This will allow us to view the statistics of the individual LAS files as well as the dataset in whole.

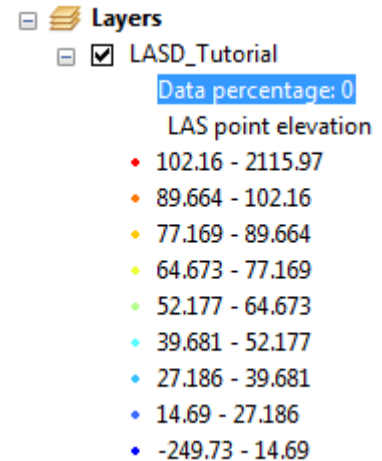
Relative paths determines how the dataset will reference the LAS files, this is suggested over absolute paths as relocating in the file system will otherwise break the reference to the data.

3. Note: LAS files are typically very large; thus processing the LAS dataset may take a few minutes. Example below, 9 adjacent tiles took 4 minutes and 22 seconds to build into an LAS dataset:

```
Start Time: Thu Jun 02 11:50:00 2016
Succeeded at Thu Jun 02 11:54:23 2016 (Elapsed Time:
4 minutes 22 seconds)
```

4. When your LAS dataset first loads into ArcMap, you likely will not see any points; only the LAS tile boundaries. Examine the ArcMap TOC (table of contents). Notice the “Data percentage: 0” highlighted below.

This figure represents the percentage of points currently visible compared to the actual number of points at its current scale.



At full scale, we are not rendering any points. The application defaults to 800,000 points to prevent crashing immediately upon loading the dataset.

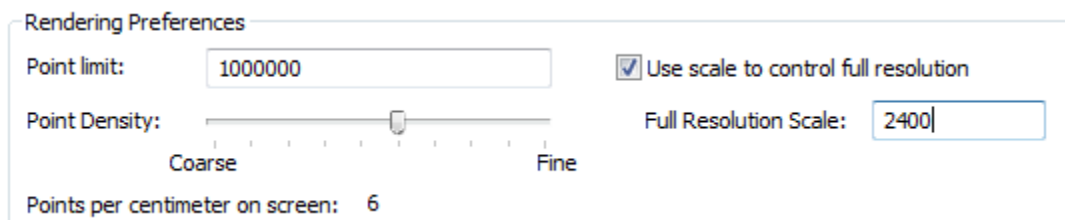
You can open the layer properties and adjust the point value; however performance will likely be affected.

As you zoom in to the dataset you will notice the data percentage increase appropriately as the points render.

5. To adjust the point rendering setting of your LAS dataset, right click the dataset in the TOC and open layer properties.

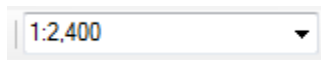
Under the “Display” tab of the LAS dataset layer properties, change the “Point limit” to 1,000,000.

Check the box for “Use scale to control full resolution” and change the “Full Resolution Scale” to 2400.



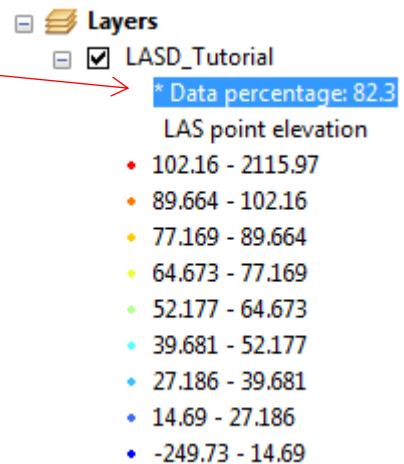
Click [OK] to apply changes and close properties window.

6. Set the map scale to 1:2400

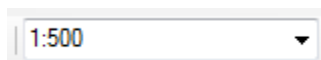


7. An asterisk (*) in the TOC next to Data Percentage indicates that there are too many points at the current scale to render 100%; resulting in point thinning or sampling.

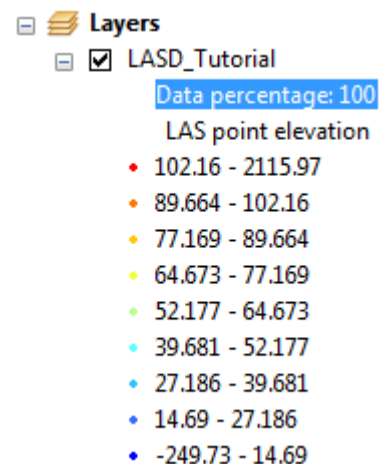
In this example, we are at the “Full Resolution Scale” set at 1:2400, however the number of points at this scale still exceeds our point limit of 1,000,000. The result is a thinning of visible points at the current scale; rendering only 82.3% of total points.



8. Set the map scale to 1:500

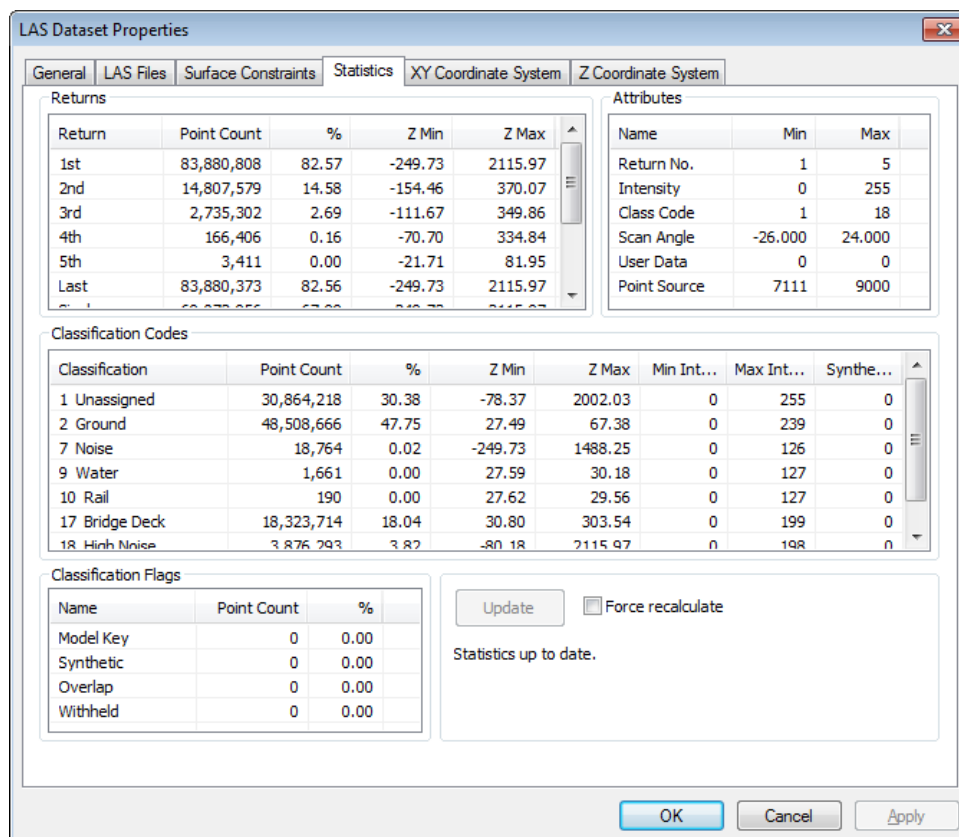
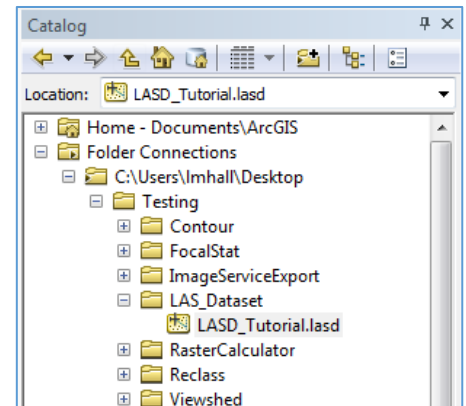


9. Now with a complete 100% view, each point in the map area represents a single point in the LAS. The point cloud at this current scale is 100% visible, without sampling or thinning occurring.



Examine Statistics

1. Open ArcMap
2. Add your LAS dataset to the map. If you have not already, go back to the previous section to [Create LAS Dataset](#)
3. Right click the LAS dataset from the Catalog window in ArcMap > Open Properties
4. Under the “Statistics” tab we can examine the LAS dataset for point counts and percentages, and identify Z minimums and maximums. We can explore these statistics by point return value or classification code.



- Statistics are also available per LAS file through the same LAS dataset properties window. Click on the LAS Files tab to access.

LAS File	Version	Point Count	Point Spacing	Z Min	Z Max	Statistics
63396101.las	1.2	12,525,032	1.382	-248.810	732.540	...
63396102.las	1.2	13,790,149	1.319	-120.270	1285.750	...
63396901.las	1.2	9,255,476	1.608	-169.060	1732.010	...
63396902.las	1.2	11,241,748	1.461	-106.650	1625.190	...
63396903.las	1.2	8,556,460	1.674	-249.730	1045.920	...
63396904.las	1.2	10,799,973	1.490	-112.360	1002.390	...
63498101.las	1.2	16,090,904	1.221	-119.520	1713.670	...
63498901.las	1.2	10,323,340	1.523	-116.170	1394.090	...
63498903.las	1.2	9,010,424	1.630	-114.430	2115.970	...

- Clicking the ellipsis [...] on the desired LAS file row will open the statistics for that individual LAS file.

Return	Point Count	%	Z Min	Z Max
1st	10,890,170	86.95	-248.81	732.54
2nd	1,371,311	10.95	-112.66	142.65
3rd	249,742	1.99	-39.69	124.08
4th	13,631	0.11	-24.34	98.58
5th	178	0.00	42.02	60.99
Last	10,890,563	86.95	-248.81	732.54


Classification	Point Count	%	Z Min	Z Max	Min Inte...	Max Inte...	Synthesi...
1 Unassigned	3,671,259	29.31	40.48	260.95	0	172	0
2 Ground	6,594,002	52.65	39.69	57.41	0	204	0
7 Noise	1,615	0.01	-248.81	732.54	0	126	0
17 Bridge Deck	1,786,051	14.26	40.41	302.03	0	147	0
18 High Noise	472,105	3.77	40.12	57.15	0	120	0

- Using the Previous/Next File buttons [Previous File Next File] you can cycle through the statistics per LAS files in your dataset.

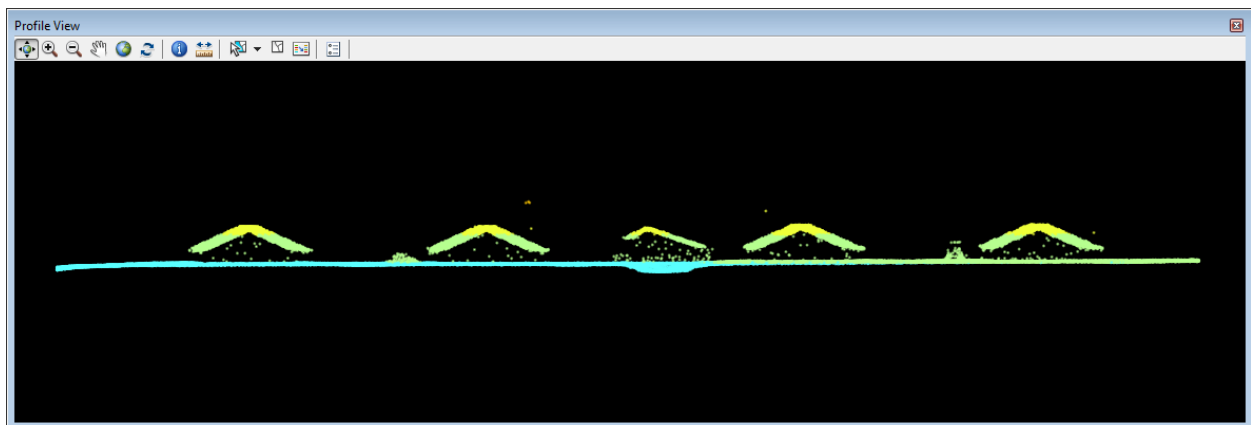
3D Point Cloud

1. Open ArcMap
2. Add your LAS dataset to the map. If you have not already, go back to the previous section to [Create LAS Dataset](#)
3. Click “Customize” in the ArcMap menu bar.
Select the “Toolbars” dropdown menu.
Navigate to and activate the “LAS Dataset” toolbar.

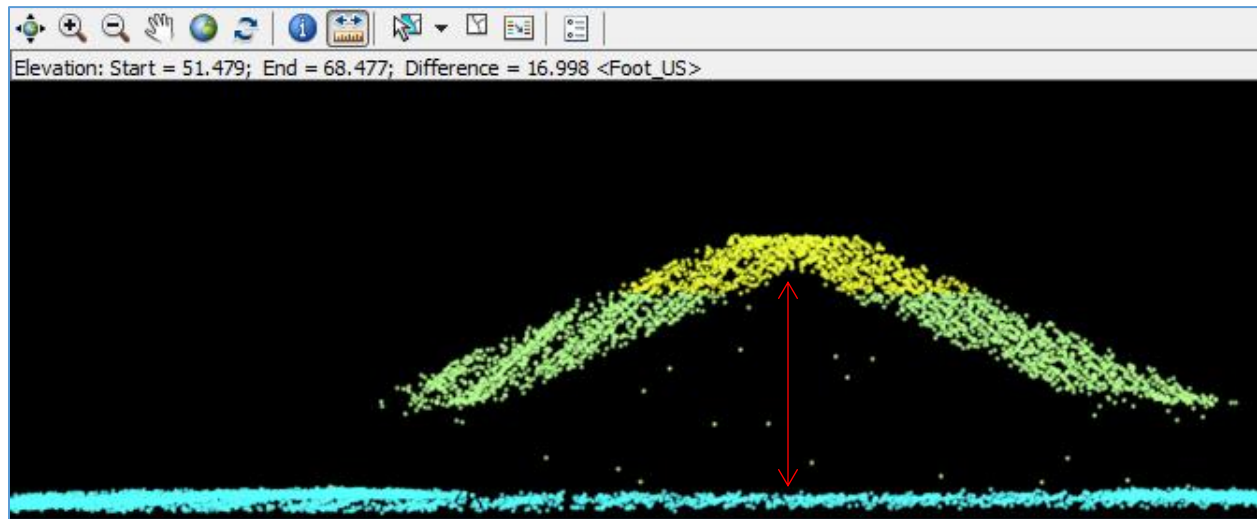




4. Zoom into an area of your LAS dataset (scale 1:1500)
5. Click “LAS Dataset Profile View” [].
Single click on the map to begin the profile, the second click will determine the length of the profile and the third click signifies the depth of the profile to be drawn.

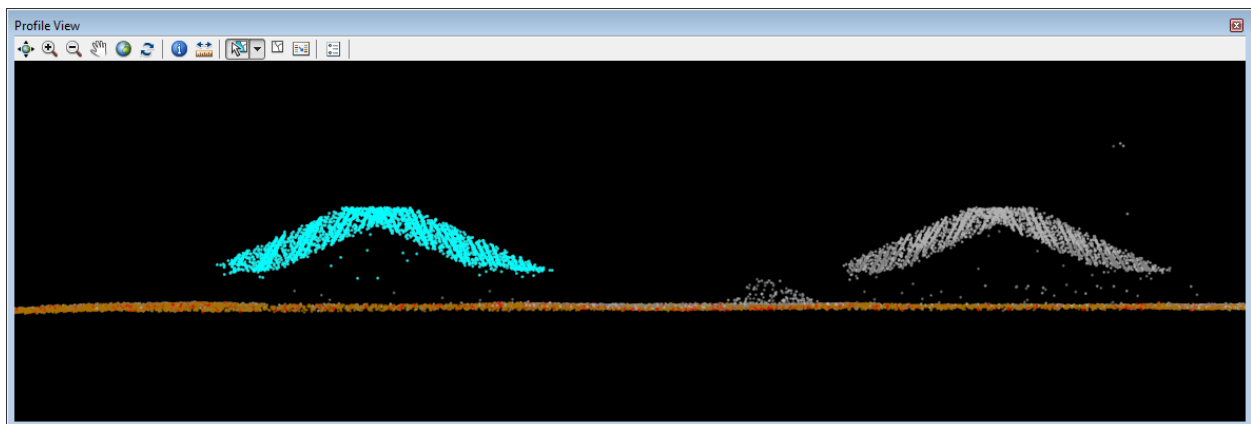
In this example we have drawn a profile view across multiple chicken house roofs.




6. Use the “Measure” tool [] in the Profile View window to measure heights and distances in your profile.



7. Close the Profile View and select “Class” from the Symbolology[] icon in the LAS Dataset Toolbar. This will change the view of the point cloud from the default (elevation values) to classification codes.
8. Draw a profile similar to before.
Use the Select [] tool, draw a polygon around a group of points.



9. Using the Edit[] tool, you can change the classification codes of the selection points.

WARNING: Changes made to point classification codes are permanent on the original LAS. Always backup original LAS files before making any edits.

10. Change the classification codes for the selection building points to class code 6.

Click [Apply] to save changes.

- 0 Never Classified
- 1 Unassigned
- 2 Ground
- 3 Low Vegetation
- 4 Medium Vegetation
- 5 High Vegetation
- 6 Building
- 7 Noise
- 8 Model Key/Reserved
- 9 Water
- 10 Rail
- 11 Road Surface
- 12 Overlap/Reserved
- 13 Wire - Guard
- 14 Wire - Conductor
- 15 Transmission Tower
- 16 Wire - Connector
- 17 Bridge Deck
- 18 High Noise

Change Class Code and Flags

Class Code

1

2

3

4

5

6

7

8

9

10

6 Building

Withheld

No Change

Key

No Change

Overlap

No Change

Synthetic

No Change

Apply

Dismiss

11. If the new class code was not already present in the current symbology, you may need to add the value to the LAS dataset properties. Right click the dataset in the TOC, open properties.

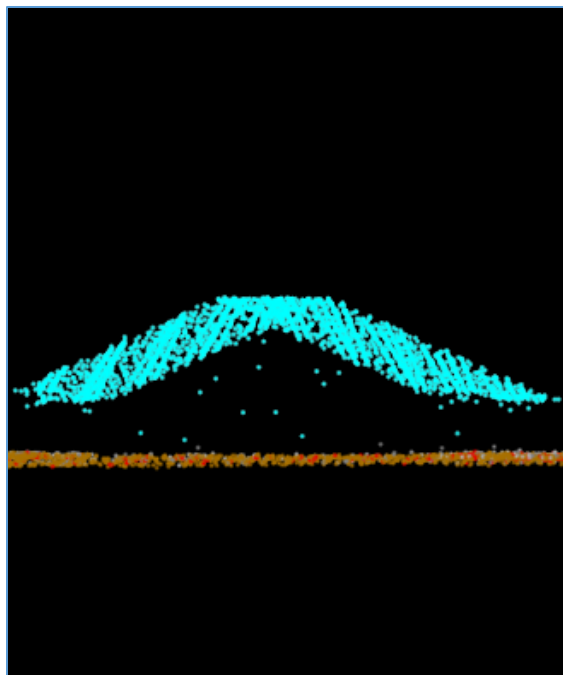
Under “Symbology” tab, click “Add Values...”

[Add Values...].

Add the new class code to the list of values for the dataset symbology.

Symbol	Value	Label	Count
<input type="checkbox"/>	<all other values>	<all other values>	255
<input type="checkbox"/>	<Heading>	<Heading>	0
•	1	1 Unassigned	0
•	2	2 Ground	0
•	6	6 Building	0
•	7	7 Noise	0
•	9	9 Water	0
•	10	10 Rail	0
•	17	17 Bridge Deck	0
•	18	18 High Noise	0

Add All Values
Add Values...
Remove Values



Information - Profile View

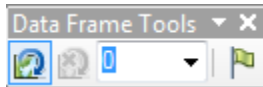
Distance and Height: (75.519651, 67.220000)



Property	Value
File Index	5
File Name	63396904.las
Folder Name	Y:\ESRGC\Projects_inprocess\LiDAR_2_0\Task_1
Point Record	1405060
Coordinates	(1643032.440, 402319.200, 67.220)
Class Code	6
Intensity	48
Return No.	1
Number of Returns	1
Classification Flag(s)	None
GPS Time	72631232.826 (Week Time)
Scan Angle	-17
Scan Direction Flag	1
Edge of Flight Line	0
User Data	0
Point Source ID	7141

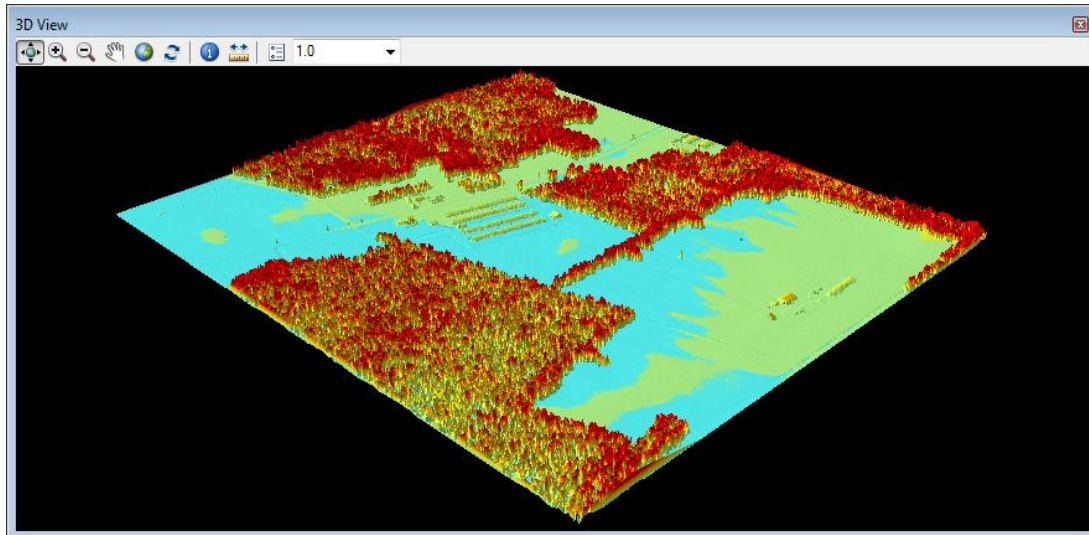
☒ Show more LAS attributes


Flash

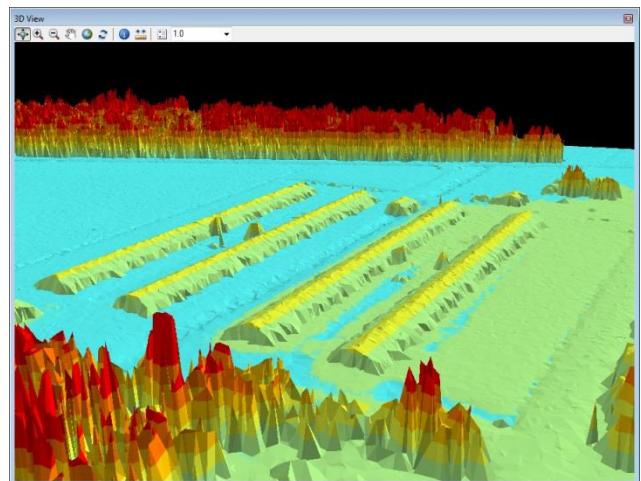
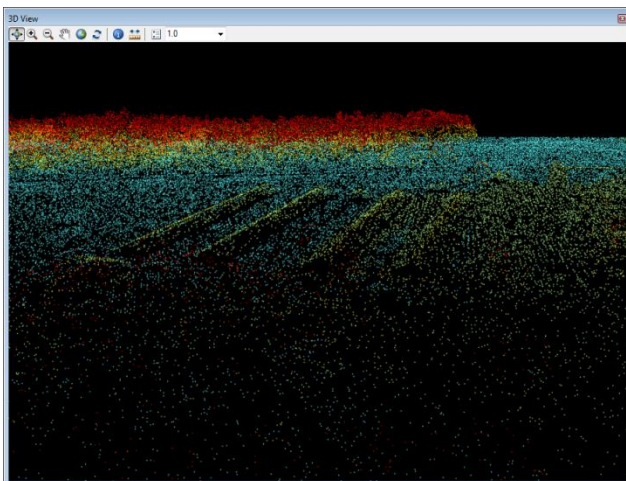
12. Turn on the “Rotate Data Frame” option from the “Data Frame Tools” toolbar



13. Select the render option for TIN [].
Select the “LAS Dataset 3D View” [] tool.



14. Using the “Navigate” [] tool:
Left mouse click and drag to rotate and tilt the map.
Center mouse scroll and drag to pan the map
Right mouse click and drag to zoom in and out.

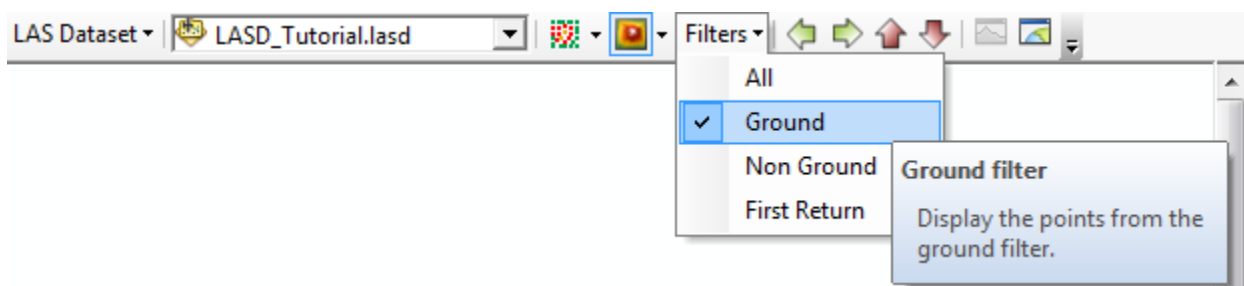


Create Surface Models from LAS

1. Open ArcMap
2. Add your LAS dataset to the map. If you have not already, go back to the previous section to [Create LAS Dataset](#)
3. Before beginning the process of LAS dataset to raster, you should consider the number of points in the dataset and the extent of coverage for your output raster.
Trying to process a few billion points may be possible; however such a demanding process is certainly cumbersome. Splitting the process into multiple raster outputs is often more efficient.
For this tutorial, our LAS dataset is only 100 million points, so processing a single raster should not be a problem.
4. The desired output cell resolution is also a key factor to consider. Inspect your metadata for NPS (nominal point spacing) and cell resolution specifications. Typically LiDAR data with an NPS of 0.7m is suitable for 1m cell resolution (3.2808399 feet).
5. You will also need to determine what type of surface model you want to generate:
To generate a DEM (Digital Elevation Model), you need to apply a filter to the LAS dataset to only return the ground points.
To generate a DSM (Digital Surface Model), you need to apply a filter to the LAS dataset to only return the first return points.

In the LAS Dataset Toolbar, select the filter options from the dropdown [**Filters**].

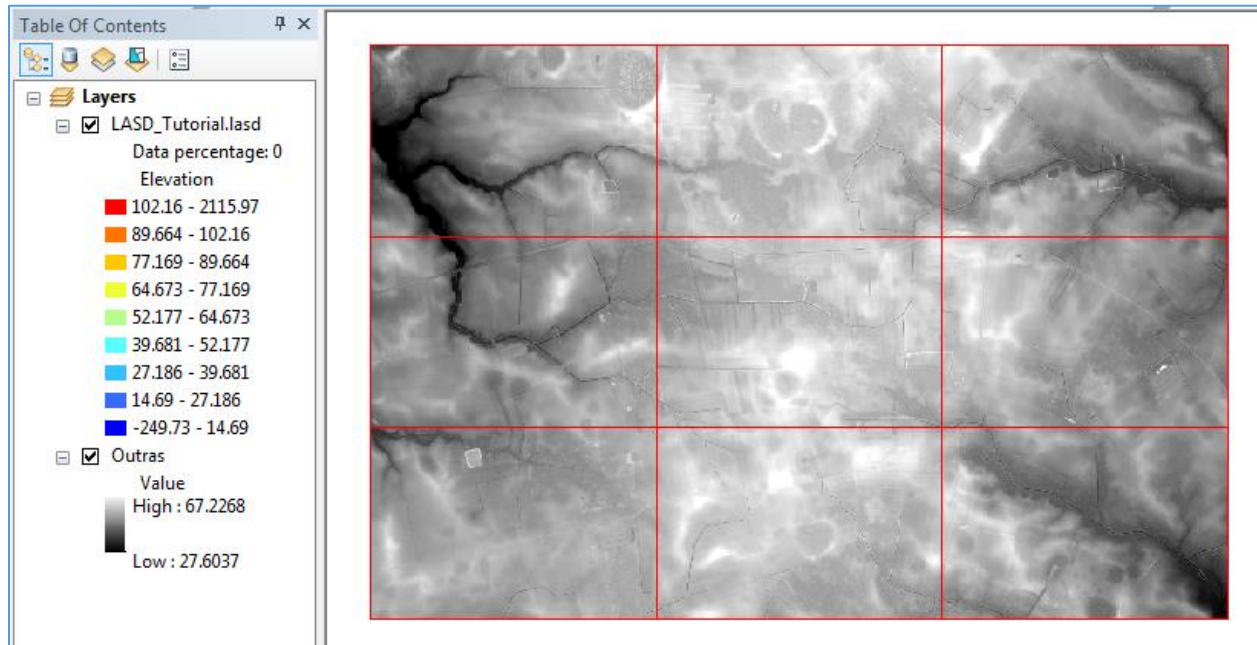
For this tutorial we will generate a DEM by selecting the Ground points filter.



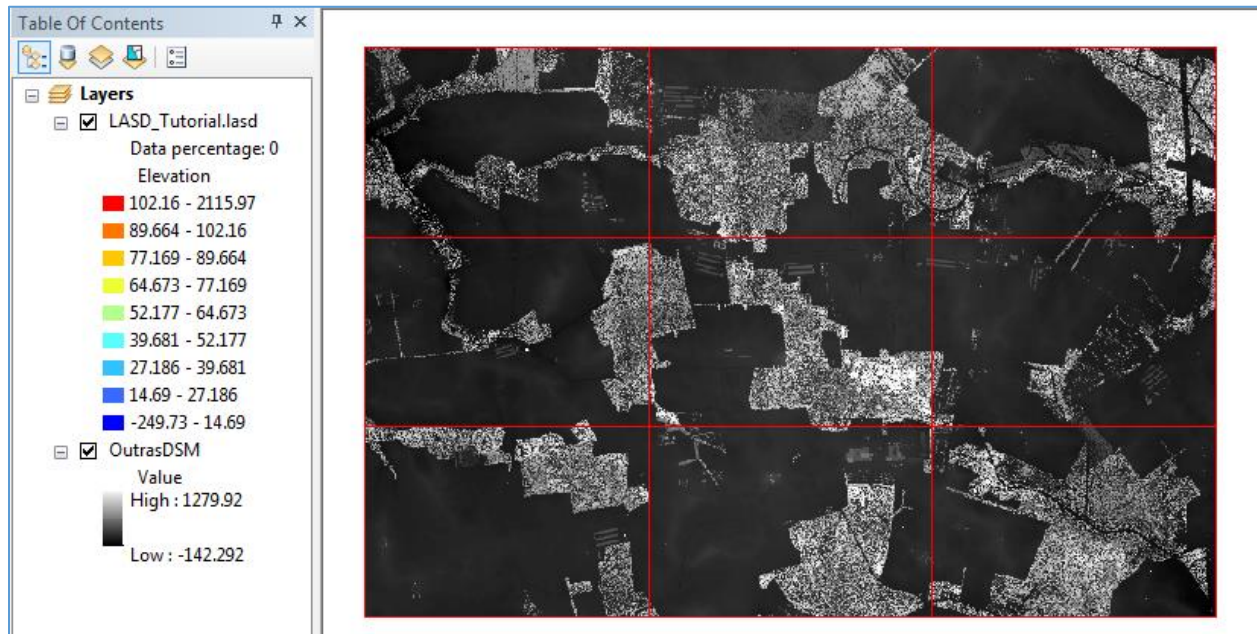
6. Using the ArcMap “Search” [🔍] tool, navigate and open the “LAS Dataset to Raster” tool. Input your LAS dataset, Select an output raster (remember: 13 character limit and name cannot start with numeric values). Select the Triangulation Interpolation Type – The Triangulation interpolation methods derive cell values using a TIN based approach. Select the sampling type: CELLSIZE Sampling value will be the output cell resolution. Set Sampling Value to 3.2808399 (the current map units are feet, this will give us 1m cells) Click [OK]

The screenshot shows the 'LAS Dataset to Raster' tool dialog box. The 'Input LAS Dataset' is 'LASD_Tutorial.lasd'. The 'Output Raster' is 'C:\Users\mhall\Desktop\Testing\LAS_Dataset\Outras'. The 'Value Field (optional)' is 'ELEVATION'. The 'Interpolation Type (optional)' has two radio buttons: 'Binning' and 'Triangulation'. Under 'Binning', 'Cell Assignment Type (Optional)' is 'AVERAGE' and 'Void Fill Method (Optional)' is 'LINEAR'. Under 'Triangulation', 'Interpolation Method (Optional)' is 'LINEAR', 'Point Thinning Type (Optional)' is 'NO_THINNING', 'Point Selection Method (Optional)' is 'MAXIMUM', and 'Resolution (Optional)' is empty. The 'Output Data Type (optional)' is 'FLOAT'. The 'Sampling Type (optional)' is 'CELLSIZE'. The 'Sampling Value (optional)' is '3.2808399'. The 'Z Factor (optional)' is '1'. The 'Tool Help' button is visible on the right.

7. DEM:



DSM:



ADDITIONAL RESOURCES

For more information about Maryland LiDAR, please visit the [Maryland LiDAR Overview page](#)

For more information about additional training opportunities, please visit the [MD iMAP Training Overview](#) page, or contact Lisa Lowe, Senior GIS Analyst with the Maryland Department of Information Technology, Geographic Information Office at lisa.lowe@maryland.gov.

For additional MD iMAP datasets, please visit the [GIS Data Catalog](#)

For all other inquiries related to Maryland LiDAR, please contact the GIO Office at service.desk@maryland.gov.

